



Proposal for a Comparison of Reliability and Maintainability Activities across ESA, JAXA, and NASA

John Evans, Frank Groen – NASA OSMA

Trilateral Meeting
ESRIN, Italy
May



Proposal

- The R&M taskforce proposes a comparative evaluation of the scope of R&M considerations (technical objectives and strategies) across the three agencies, and common tools, techniques, and standards used to implement those strategies.
- The task force proposes to consider the elements of the NASA R&M framework, as captured in the hierarchy of R&M considerations, to identify commonalities and differences in the way reliability and maintainability is addressed by the flight projects.
- In addition, the task force will consider lessons learned from past projects concerning international cooperation.

Objectives Based Hierarchy: Overview

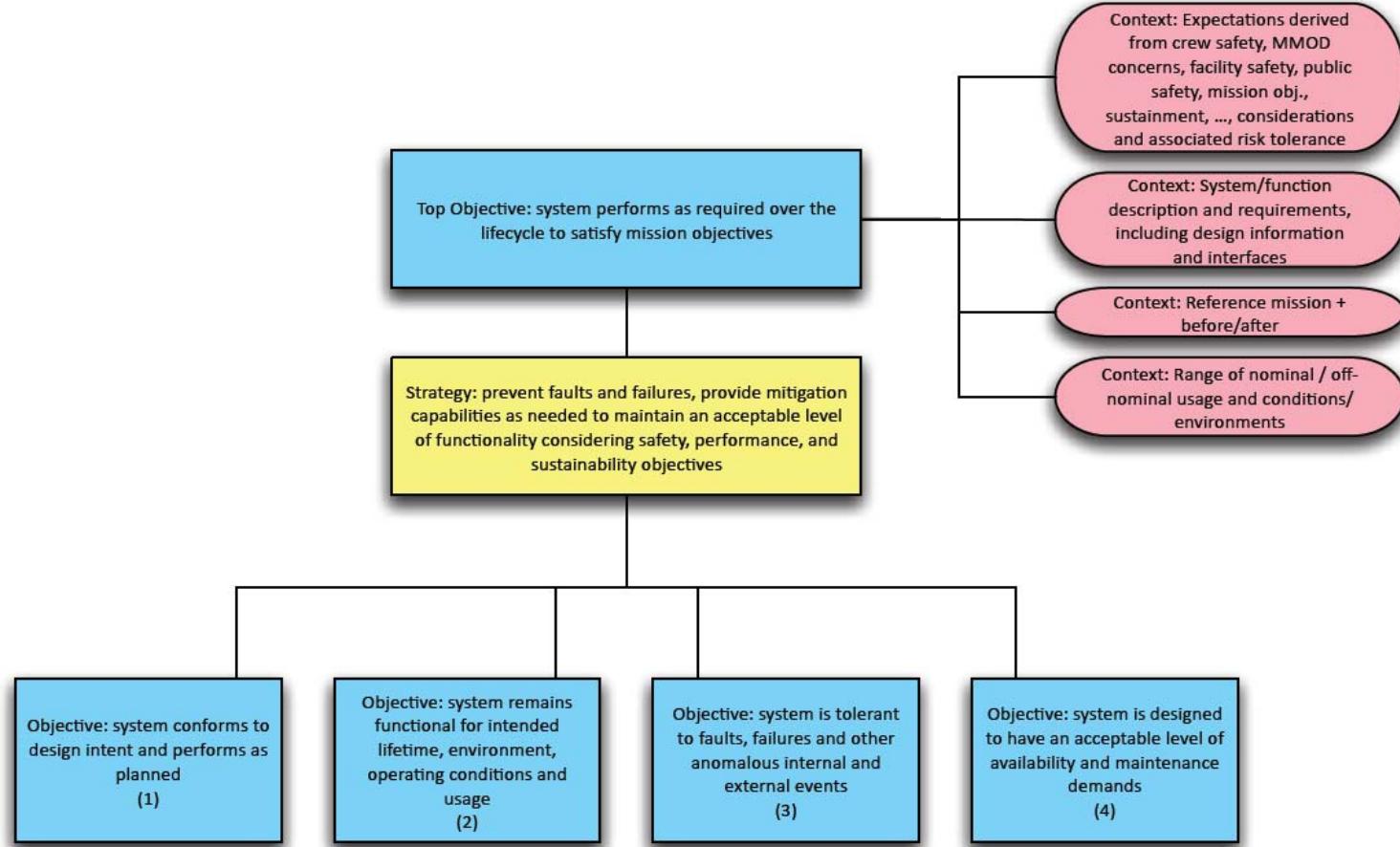


- Logically decompose top-level R&M objective
 - Use elements of the Goal Structuring Notation
 - Structure shows why strategies are to be applied
- Structure forms basis for R&M activities
 - Specifies the technical considerations to be addressed by projects
 - Basis for evaluation of plans, design, and assurance products



Decomposition of R&M Objectives

R&M Objectives Structure – Top-Level





Decomposition of R&M Objectives

R&M Hierarchy

Sub – Obj.

2

Objective: system and its elements are designed to withstand nominal and extreme loads and stresses (radiation, temperature, pressure, mechanical, ...) for the life of the mission
(2.A.1)

Strategy: Apply design standards to incorporate margin to account for variable and unknown stresses
(2.A.1.A)

Strategy: Evaluate and control nominal stresses and related failure causes
(2.A.1.B)

Strategy: Evaluate and control potential for extreme stresses and related failure causes
(2.A.1.C)

Strategy: Perform qualification testing and life demonstration to verify design for intended use
(2.A.1.D)

Objective: System remains functional for intended lifetime, environment, operating conditions and usage
(2)

Strategy: Understand failure mechanisms, eliminate and/or control failure causes, degradation and common cause failures, and limit failure propagation to reduce likelihood of failure to an acceptable level
(2.A)

Objective: System or its elements are not susceptible to common-cause failures
(2.A.2)

Strategy: Assess quantitative reliability measures and recommend or support changes to system design and/or operations
(2.B)

Objective: System and its components meet quantitative reliability criteria
(2.B.1)

Strategy: Determine reliability allocation
(2.B.1.A)

Strategy: Estimate reliability based on applicable performance data, historical data of similar systems, and/or physics-based modeling
(2.B.1.B)

Strategy: Support design trades based on reliability analysis
(2.B.1.C)

Strategy: Plan and perform life testing
(2.B.1.D)

Strategy: Track and monitor reliability performance over time
(2.B.1.E)



Analysis and Comparison

		Evidence	Scope						
			Human Space Flight	Class A	Class B	Class C	Class D	Research and Technology	Ground Based Systems
1.C	Strategy: Achieve high level of process reliability								
1.C.1	Objective: Built system and its components do not contain flaws/faults that reduce ability to withstand loads and stresses								
1.C.1.A	Strategy: Select appropriate quality components and materials	approved parts list; parts control and traceability; materials review; approved vendors list;	Parts/materials control standards applicable to Human Space Flight:	Parts/materials control standards applicable to individual mission class				Parts/materials control standards applicable to research and technology	Parts/materials control standards applicable to ground based systems, if they exist:
1.C.1.B	Strategy: Perform process reliability reviews to ensure consistency of reliability design processes with interdependant engineering analyses	technical oversight & management; independent technical review; peer technical review; software process audit	High rigor review of all reliability design processes and engineering analyses		Selective review of reliability design processes and engineering analyses based on high risk drivers			For telemetry items, same scope as Class A/B. For other items, selective review as in Class C/D	
1.C.1.C	Strategy: Establish and verify manufacturing processes and handling criteria	approved parts list; ground handling analysis; process variance analysis; process FMEA; ground handling test; process capability assessment	Parts control handling standards and manufacturing criteria applicable to Human Space Flight:	Parts control handling standards and manufacturing criteria applicable to individual mission class			Parts control handling standards and manufacturing criteria applicable to research and technology	Parts control handling standards and manufacturing criteria applicable to ground based systems, if they exist:	
1.C.1.D	Strategy: Screening, proof testing and acceptance testing	Environmental Stress Screening, inspection Criteria, Acceptance Test Plan	Test/Screen at full level of rigor (duration, number of cycles, etc. for ESS). Test/Screen will be tailored based on criticality			Tier/Screen at decreased level of rigor than lower risk classes (box level). Test/Screen will be tailored based on criticality		Verify functionality of ground support equipment used for testing. Screen/proof testing of safety elements	



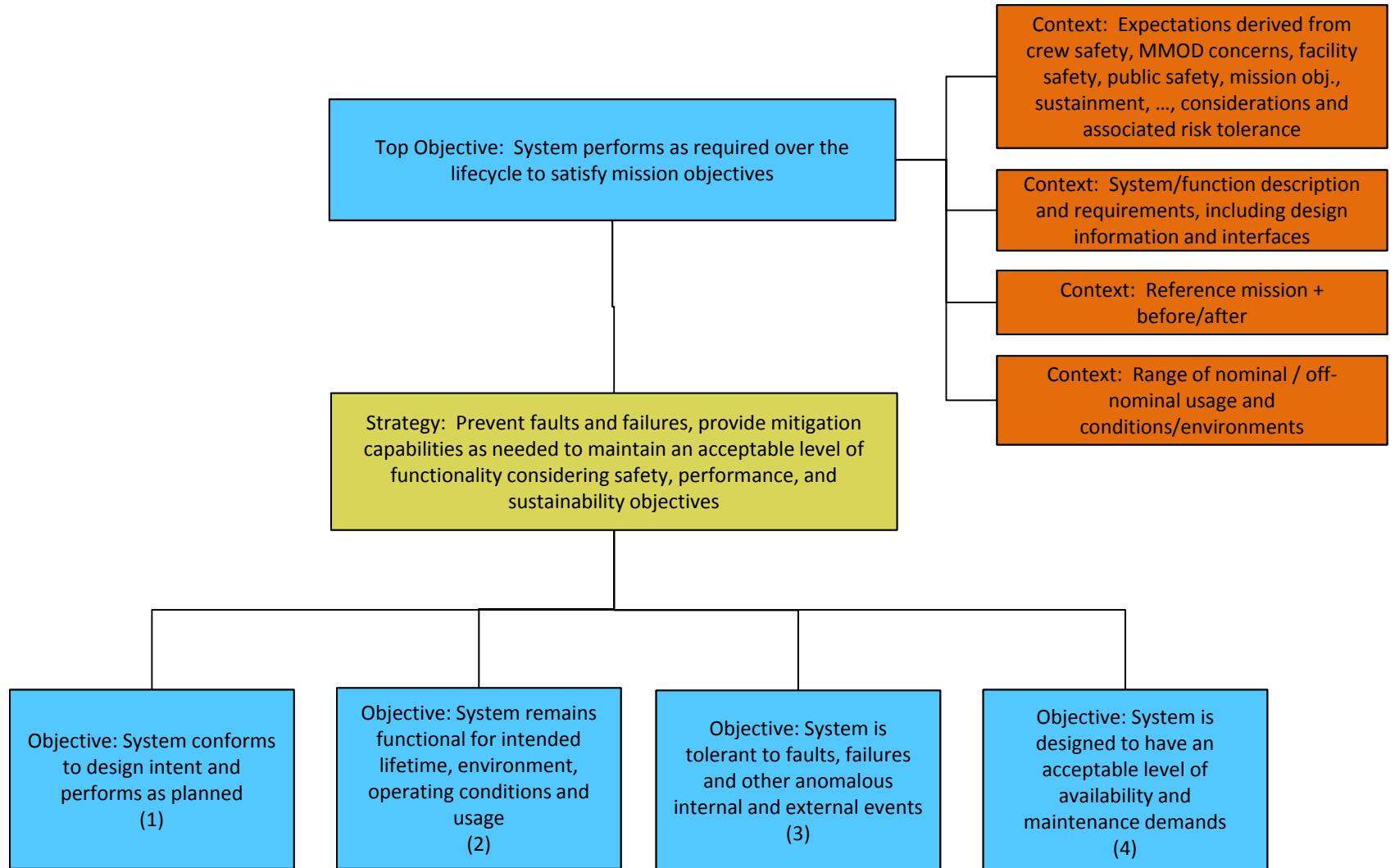
Output

- The output of the comparison will be a report structured in accordance with the Provisions in Support of the Mutual Recognition of Safety & Mission Assurance Standards in Cooperative Programs.
- This report would address area 5.o Dependability Assurance with particular focus on Reliability and Maintainability, herein referred to as R&M.
- Completion of the report is targeted by the next trilateral SMA meeting.



R & M Heirarchy

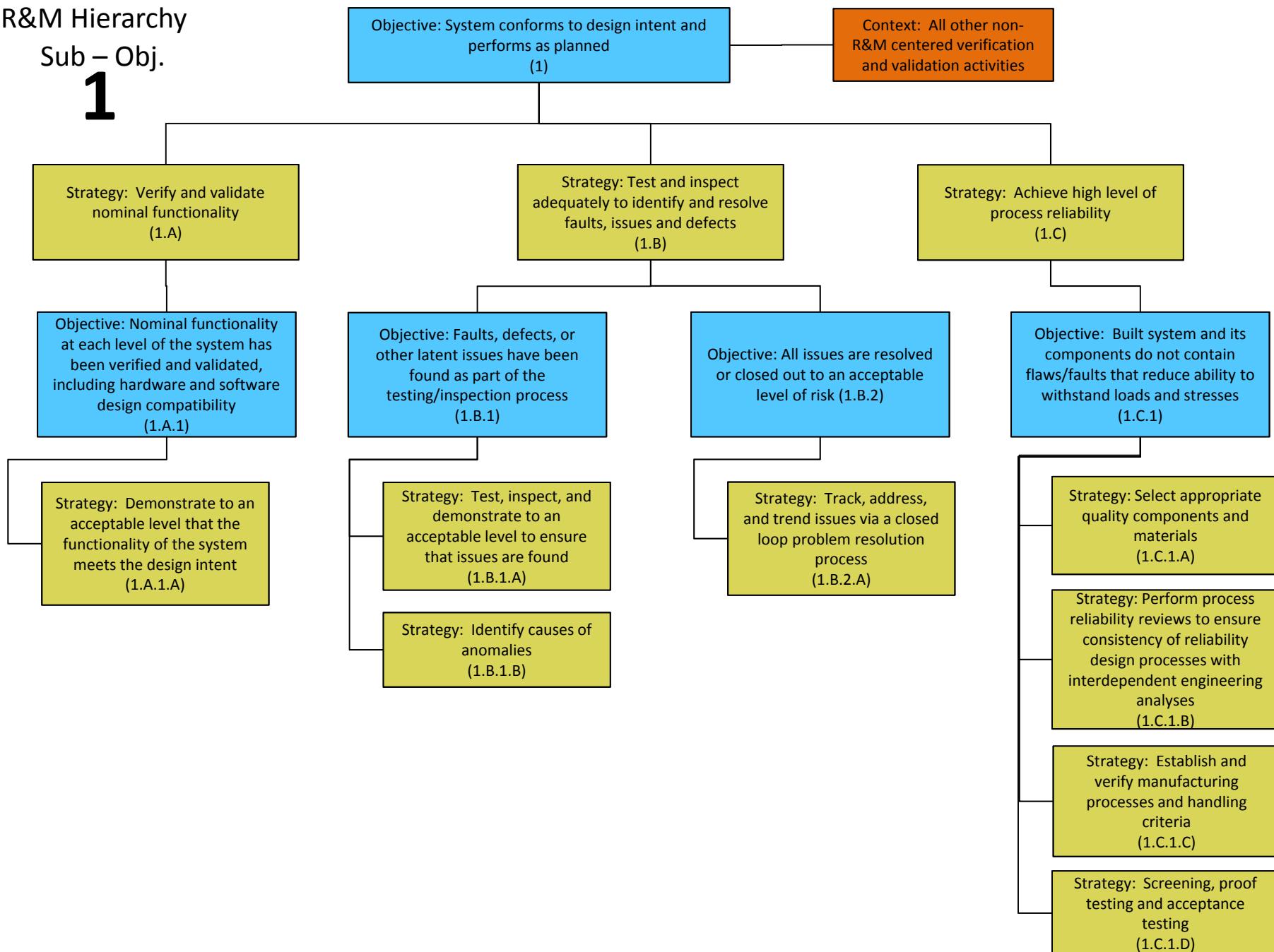
R&M Objectives Hierarchy – Top Level



R&M Hierarchy

Sub – Obj.

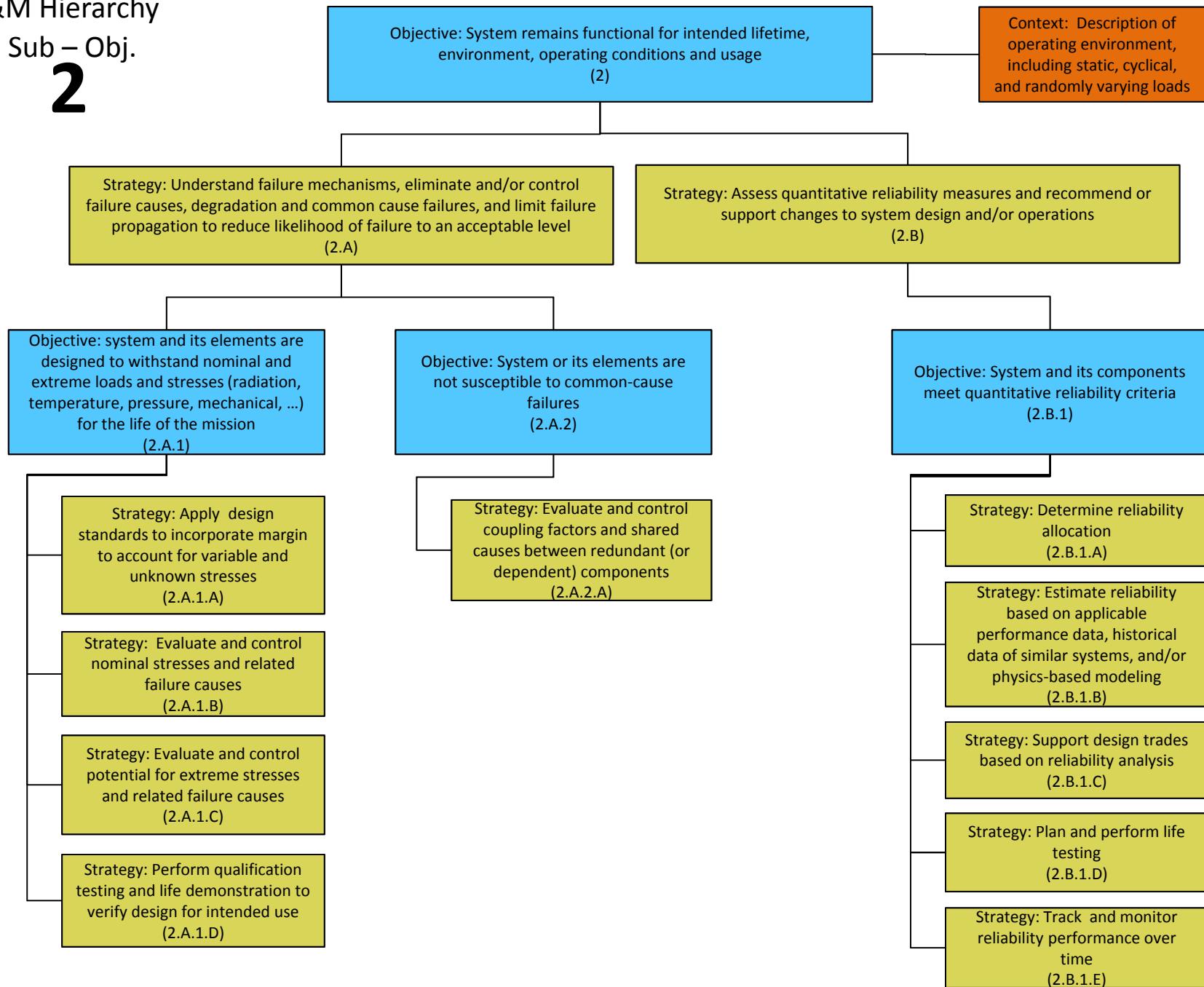
1



R&M Hierarchy

Sub – Obj.

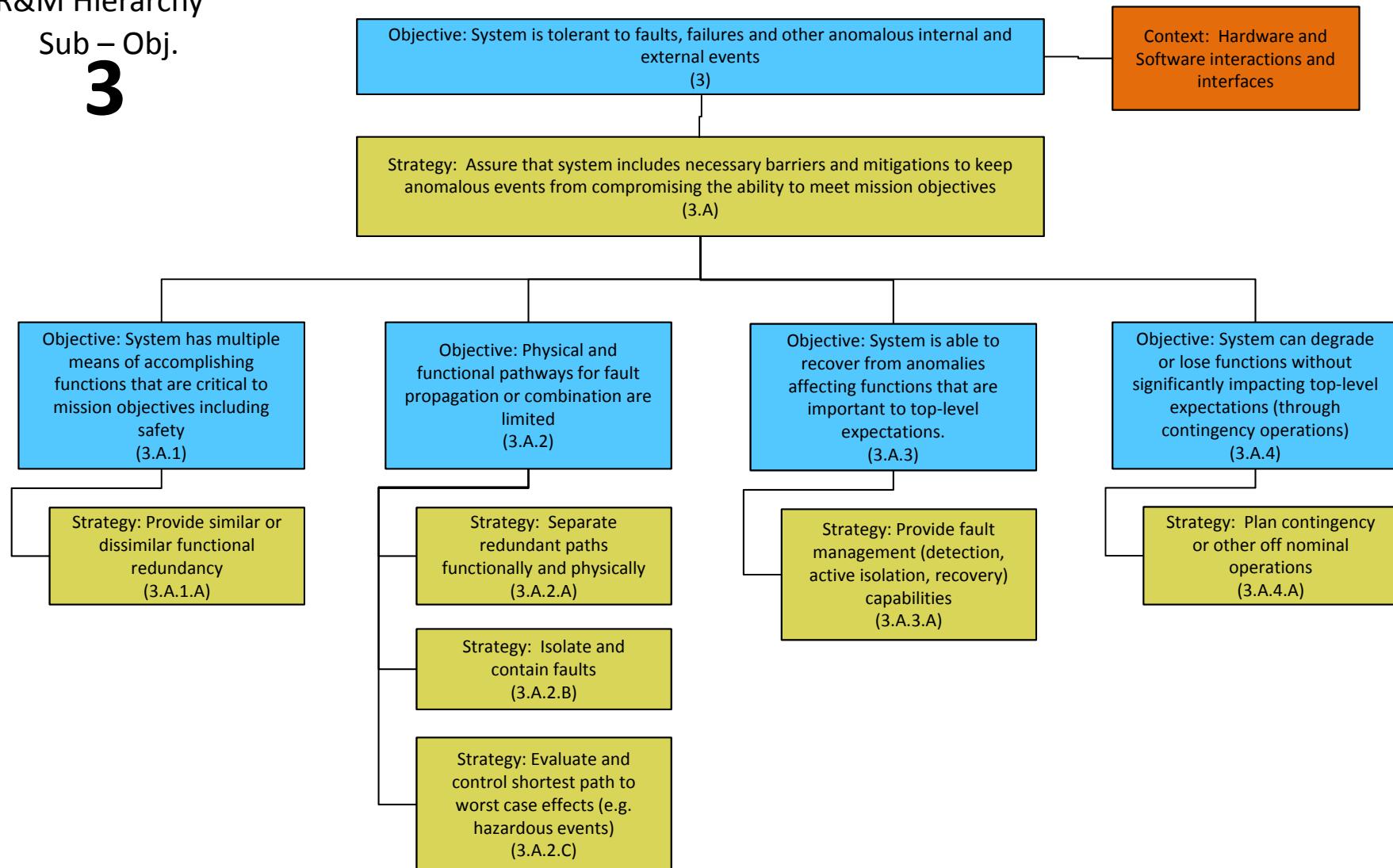
2



R&M Hierarchy

Sub – Obj.

3



R&M Hierarchy

Sub – Obj.

4

